



[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA-2017-0318; Special Conditions No. 25-693-SC]

Special Conditions: Embraer S.A. Model ERJ 190-300 airplane; Interaction of Systems and Structures

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions; request for comments.

SUMMARY: These special conditions are issued for the Embraer S.A. (Embraer) Model ERJ 190-300 airplane. This airplane will have novel or unusual design features when compared to the state of technology envisioned in the airworthiness standards for transport-category airplanes. These design features include systems that, directly or as a result of failure or malfunction, affect airplane structural performance. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

DATES: This action is effective on Embraer on **[INSERT DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. Send your comments by **[INSERT DATE 45 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]**.

ADDRESSES: Send comments identified by docket number FAA-2017-0318 using any of the following methods:

- *Federal eRegulations Portal:* Go to <http://www.regulations.gov/> and follow the online instructions for sending your comments electronically.
- *Mail:* Send comments to Docket Operations, M-30, U.S. Department of Transportation (DOT), 1200 New Jersey Avenue, SE., Room W12-140, West Building Ground Floor, Washington, DC, 20590-0001.
- *Hand Delivery or Courier:* Take comments to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- *Fax:* Fax comments to Docket Operations at 202-493-2251.

Privacy: The FAA will post all comments it receives, without change, to <http://www.regulations.gov/>, including any personal information the commenter provides. Using the search function of the docket Web site, anyone can find and read the electronic form of all comments received into any FAA docket, including the name of the individual sending the comment (or signing the comment for an association, business, labor union, etc.). DOT's complete Privacy Act Statement can be found in the **Federal Register** published on April 11, 2000 (65 FR 19477-19478).

Docket: Background documents or comments received may be read at <http://www.regulations.gov/> at any time. Follow the online instructions for accessing the docket or go to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Greg Schneider, FAA, Airframe and Cabin Safety Branch, ANM-115, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW., Renton, Washington 98057-3356; telephone 425-227-2116; facsimile 425-227-1320.

SUPPLEMENTARY INFORMATION:

The FAA has determined that notice of, and opportunity for prior public comment on, these special conditions is impracticable because these procedures would significantly delay issuance of the design approval and thus delivery of the affected airplanes.

In addition, the substance of these special conditions has been subject to the public-comment process in several prior instances with no substantive comments received. The FAA therefore finds it unnecessary to delay the effective date and that good cause exists for making these special conditions effective upon publication in the **Federal Register**.

Comments Invited

We invite interested people to take part in this rulemaking by sending written comments, data, or views. The most helpful comments reference a specific portion of the special conditions, explain the reason for any recommended change, and include supporting data.

We will consider all comments we receive by the closing date for comments. We may change these special conditions based on the comments we receive.

Background

On September 13, 2013, Embraer applied for an amendment to Type Certificate No. A57NM to include the new Model ERJ 190-300 airplane. The Model ERJ 190-300 airplane, which is a derivative of the Embraer Model ERJ 190-100 STD airplane currently approved under

Type Certificate No. A57NM, is a 97- to 114-passenger transport-category airplane. The maximum take-off weight is 124,340 lbs (56,400 kg).

Type Certification Basis

Under the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.101, Embraer must show that the Model ERJ 190-300 airplane meets the applicable provisions of the regulations listed in Type Certificate No. A57NM, or the applicable regulations in effect on the date of application for the change, except for earlier amendments as agreed upon by the FAA.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for the Model ERJ 190-300 airplane because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the type certificate for that model be amended later to include any other model that incorporates the same novel or unusual design feature, or should any other model already included on the same type certificate be modified to incorporate the same novel or unusual design feature, these special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, the Model ERJ 190-300 airplane must comply with the fuel-vent and exhaust-emission requirements of 14 CFR part 34 and the noise-certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type certification basis under § 21.101.

Novel or Unusual Design Features

The Embraer Model ERJ 190-300 airplane will incorporate the following novel or unusual design feature:

Systems that, directly or as a result of failure or malfunction, affect airplane structural performance. That is, the airplane's systems affect how it responds in maneuver and gust conditions, and thereby affect its structural capability. These systems may also affect the aeroelastic stability of the airplane. Such systems include flight control systems, autopilots, stability augmentation systems, load alleviation systems, and fuel management systems. These systems represent novel and unusual features when compared to the technology envisioned in the current airworthiness standards.

Discussion

Special conditions have been applied on past airplane programs to require consideration of the effects of systems on structures. The regulatory authorities and industry developed standardized criteria in the Aviation Rulemaking Advisory Committee (ARAC) forum based on the criteria defined in Advisory Circular (AC) 25.672-1, dated November 15, 1983. The ARAC recommendations have been incorporated in European Aviation Safety Agency (EASA) Certification Specifications (CS) 25.302 and CS 25 Appendix K, which are applicable to Embraer. FAA rulemaking on this subject is not complete, thus the need for the special conditions.

The special conditions are similar to those previously applied to other airplane models and to the requirements of CS 25.302. The major differences between these special conditions and the current CS 25.302 are as follows:

1) Both the special conditions and CS 25.302 (and by reference Appendix K) specify the design load conditions to be considered. Effects of Systems on Structures, special conditions 2.a. and 3.b.i. clarify that, in some cases, different load conditions are to be considered due to other special conditions or equivalent-level-of-safety findings.

2) Both the special conditions (see special condition 5, below) and CS 25.302 allow consideration of the probability of being in a dispatched configuration when assessing subsequent failures and potential “continuation of flight” loads. The special conditions, however, also allow using probability when assessing failures that induce loads at the “time of occurrence,” whereas CS 25.302 does not.

These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

Applicability

As discussed above, these special conditions are applicable to the Embraer Model ERJ 190-300 airplane. Should Embraer apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, these special conditions would apply to that model as well.

Conclusion

This action affects only a certain novel or unusual design feature on one model of airplane. It is not a rule of general applicability.

The substance of these special conditions has been published in the Federal Register for public comment in several prior instances and has been derived without substantive change from those previously issued. It is unlikely that prior public comment would result in a significant

change from the substance contained herein. Therefore, the FAA has determined that prior public notice and comment are unnecessary and impracticable, and good cause exists for adopting these special conditions upon publication in the **Federal Register**. The FAA is requesting comments to allow interested persons to submit views that may not have been submitted in response to the prior opportunities for comment described above.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for Embraer Model ERJ 190-300 airplanes.

For airplanes equipped with systems that affect structural performance, either directly or as a result of a failure or malfunction, the influence of these systems and their failure conditions must be taken into account when showing compliance with the requirements of part 25, subparts C and D.

For airplanes equipped with flight-control systems, autopilots, stability-augmentation systems, load-alleviation systems, fuel-management systems, and other systems that either directly, or as a result of failure or malfunction, affect structural performance, the following criteria must be used for showing compliance. If these special conditions are used for other systems, it may be necessary to adapt the criteria to the specific system.

1. The criteria defined herein only address the direct structural consequences of the system responses and performance. They cannot be considered in isolation, but should be included in the overall safety evaluation of the airplane. These criteria may, in some instances, duplicate standards already established for this evaluation. These criteria are only applicable to structure the failure of which could prevent continued safe flight and landing. Specific criteria that define acceptable limits on handling characteristics or stability requirements, when operating in the system-degraded or inoperative mode, are not provided in these special conditions.
2. Depending upon the specific characteristics of the airplane, additional studies that go beyond the criteria provided in these special conditions may be required to demonstrate the airplane's capability to meet other realistic conditions, such as alternative gust or maneuver descriptions for an airplane equipped with a load-alleviation system.
3. The following definitions are applicable to these special conditions.
 - a. **Structural performance:** Capability of the airplane to meet the structural requirements of part 25.
 - b. **Flight limitations:** Limitations that can be applied to the airplane flight conditions following an in-flight occurrence, and that are included in the airplane flight manual (e.g., speed limitations, avoidance of severe weather conditions, etc.).
 - c. **Operational limitations:** Limitations, including flight limitations, that can be applied to the airplane operating conditions before dispatch (e.g., fuel, payload and master minimum-equipment list limitations).

- d. **Probabilistic terms:** Terms such as probable, improbable, and extremely improbable, as used in these special conditions, are the same as those used in § 25.1309.
- e. **Failure condition:** This term is the same as that used in § 25.1309. However, these special conditions apply only to system-failure conditions that affect the structural performance of the airplane (e.g., system-failure conditions that induce loads, change the response of the airplane to inputs such as gusts or pilot actions, or lower flutter margins).

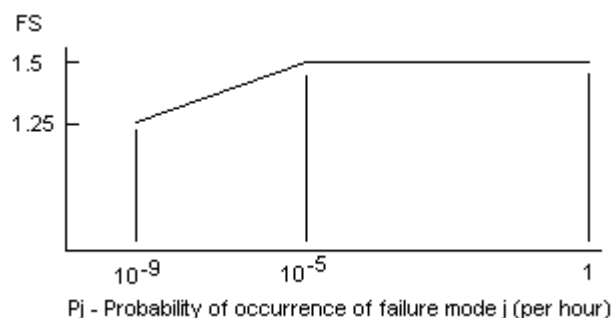
Effects of Systems on Structures

1. **General.** The following criteria will be used in determining the influence of a system and its failure conditions on the airplane structure.
2. **System fully operative.** With the system fully operative, the following apply:
 - a. Limit loads must be derived in all normal operating configurations of the system from all the limit conditions specified in part 25, subpart C (or defined by special conditions or findings of equivalent level of safety in lieu of those specified in subpart C), taking into account any special behavior of such a system or associated functions, or any effect on the structural performance of the airplane that may occur up to the limit loads. In particular, any significant nonlinearity (rate of displacement of control surface, thresholds, or any other system nonlinearities) must be accounted for in a realistic or conservative way when deriving limit loads from limit conditions.
 - b. The airplane must meet the strength requirements of part 25 (static strength, residual strength), using the specified factors to derive ultimate loads from the

limit loads defined above. The effect of nonlinearities must be investigated beyond limit conditions to ensure that the behavior of the system presents no anomaly compared to the behavior below limit conditions. However, conditions beyond limit conditions need not be considered when it can be shown that the airplane has design features that will not allow it to exceed those limit conditions.

- c. The airplane must meet the aeroelastic stability requirements of § 25.629.
3. **System in the failure condition.** For any system-failure condition not shown to be extremely improbable, the following apply:
- a. At the time of occurrence. Starting from 1g level flight conditions, a realistic scenario, including pilot corrective actions, must be established to determine the loads occurring at the time of failure and immediately after the failure.
 - i. For static-strength substantiation, these loads, multiplied by an appropriate factor of safety that is related to the probability of occurrence of the failure, are ultimate loads to be considered for design. The factor of safety is defined in Figure 1, below.

Figure 1: Factor of safety (FS) at the time of occurrence

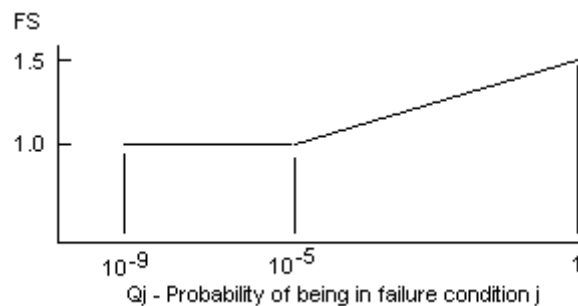


- ii. For residual-strength substantiation, the airplane must be able to withstand two thirds of the ultimate loads defined in special condition

- 3.a.i. For pressurized cabins, these loads must be combined with the normal operating differential pressure.
 - iii. Freedom from aeroelastic instability must be shown up to the speeds defined in § 25.629(b)(2). For failure conditions that result in speeds beyond V_C/M_C , freedom from aeroelastic instability must be shown to increased speeds, so that the margins intended by § 25.629(b)(2) are maintained.
 - iv. Failures of the system that result in forced structural vibrations (oscillatory failures) must not produce loads that could result in detrimental deformation of primary structure.
- b. For the continuation of the flight. For the airplane in the system-failed state, and considering any appropriate reconfiguration and flight limitations, the following apply:
- i. The loads derived from the following conditions (or defined by special conditions or findings of equivalent level of safety in lieu of the following conditions) at speeds up to V_C/M_C (or the speed limitation prescribed for the remainder of the flight) must be determined:
 - 1. the limit symmetrical maneuvering conditions specified in §§ 25.331 and 25.345.
 - 2. the limit gust and turbulence conditions specified in §§ 25.341 and 25.345.

3. the limit rolling conditions specified in § 25.349, and the limit unsymmetrical conditions specified in §§ 25.367, and 25.427(b) and (c).
 4. the limit yaw-maneuvering conditions specified in § 25.351.
 5. the limit ground-loading conditions specified in §§ 25.473, 25.491, 25.493(d), and 25.503.
- ii. For static-strength substantiation, each part of the structure must be able to withstand the loads in special condition 3.b.i., multiplied by a factor of safety depending on the probability of being in this failure state. The factor of safety is defined in Figure 2, below.

Figure 2: Factor of safety (FS) for continuation of flight



$Q_j = (T_j)(P_j)$ where:

T_j = Average time spent in failure mode j (in hours)

P_j = Probability of occurrence of failure mode j (per hour)

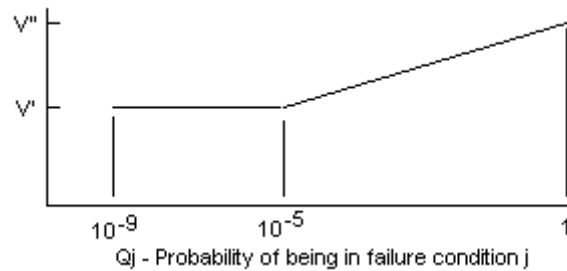
Note: If P_j is greater than 10^{-3} per flight hour, then a 1.5 factor of safety must be applied to all limit load conditions specified in part 25, subpart C.

- iii. For residual-strength substantiation, the airplane must be able to withstand two-thirds of the ultimate loads defined in paragraph 3.b.ii. of

these special conditions. For pressurized cabins, these loads must be combined with the normal operating differential pressure.

- iv. If the loads induced by the failure condition have a significant effect on fatigue or damage tolerance, then their effects must be taken into account.
- v. Freedom from aeroelastic instability must be shown up to a speed determined from Figure 3, below. Flutter clearance speeds V' and V'' may be based on the speed limitation specified for the remainder of the flight using the margins defined by § 25.629(b).

Figure 3: Clearance speed



V' = Clearance speed as defined by § 25.629(b)(2).

V'' = Clearance speed as defined by § 25.629(b)(1).

$Q_j = (T_j)(P_j)$ where:

T_j = Average time spent in failure mode j (in hours)

P_j = Probability of occurrence of failure mode j (per hour)

Note: If P_j is greater than 10^{-3} per flight hour, then the flutter clearance speed must not be less than V'' .

vi. Freedom from aeroelastic instability must also be shown up to V' in Figure 3, above, for any probable system-failure condition, combined with any damage required or selected for investigation by § 25.571(b).

c. Consideration of certain failure conditions may be required by other sections of part 25 regardless of calculated system reliability. Where analysis shows the probability of these failure conditions to be less than 10^{-9} per flight hour, criteria other than those specified in this paragraph may be used for structural substantiation to show continued safe flight and landing.

4. **Failure indications.** For system-failure detection and indication, the following apply:

a. The system must be checked for failure conditions, not extremely improbable, that degrade the structural capability below the level required by part 25, or that significantly reduce the reliability of the remaining system. As far as reasonably practicable, the flightcrew must be made aware of these failures before flight.

Certain elements of the control system, such as mechanical and hydraulic components, may use special periodic inspections, and electronic components may use daily checks, in lieu of detection and indication systems, to achieve the objective of this requirement. These certification-maintenance requirements must be limited to components that are not readily detectable by normal detection-and-indication systems, and where service history shows that inspections will provide an adequate level of safety.

b. The existence of any failure condition, not extremely improbable, during flight, that could significantly affect the structural capability of the airplane, and for which the associated reduction in airworthiness can be minimized by suitable

flight limitations, must be signaled to the flightcrew. For example, failure conditions that result in a factor of safety between the airplane strength and the loads of part 25, subpart C below 1.25, or flutter margins below V'' , must be signaled to the crew during flight.

5. **Dispatch with known failure conditions.** If the airplane is to be dispatched in a known system-failure condition that affects structural performance, or that affects the reliability of the remaining system to maintain structural performance, then the provisions of these special conditions must be met, including the provisions of special condition 2 for the dispatched condition, and special condition 3 for subsequent failures. Expected operational limitations may be taken into account in establishing P_j as the probability of failure occurrence for determining the safety margin in Figure 1. Flight limitations and expected operational limitations may be taken into account in establishing Q_j as the combined probability of being in the dispatched failure condition and the subsequent failure condition for the safety margins in Figures 2 and 3. These limitations must be such that the probability of being in this combined failure state, and then subsequently encountering limit load conditions, is extremely improbable. No reduction in these safety margins is allowed if the subsequent system-failure rate is greater than 10^{-3} per flight hour.

Issued in Renton, Washington.

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